However, exactly how many C-33s or C-5s would be needed to replace the delivery capability of a given number of C-17s is subject to debate. Although the C-17 carries a smaller payload, its size does have an important benefit: making airfields that have a limited amount of ramp space for parking and loading more accessible.

Air Force officials argue that since the C-17 is smaller, more maneuverable on the ground, and can be loaded or unloaded quickly, it holds an advantage when airfield conditions are constrained. DoD's major planning scenarios—Korea and Southwest Asia—include several large airfields.[6] But the maximum number of planes that can be serviced on an airfield can change at any given time, depending on such factors as the availability of ramp space, fuel, manpower, and equipment for loading and unloading aircraft. For that reason, it is difficult to say to what degree ramp space and other factors could constrain deliveries to two major regional conflicts.

Using planned deployments for two "concurrent sequential" conflicts in Southwest Asia and Korea, a 1993 study by the Institute for Defense Analyses showed that a fleet of 120 C-17s could deliver more outsize cargo than fleets that included a mixture of C-17s and modified commercial wide-body planes when airfields were constrained as tightly as they were early in Operation Desert Shield. However, when airfield space was less cramped, alternative fleets could meet airlift requirements for the first 30 days of a major conflict at lower cost.[7]

To provide more up-to-date information about how well a mixture of planes can deliver cargo, the Air Force has been conducting a study called the Strategic Airlift Force Mix Analysis (SAFMA). The study focuses on airlift requirements in the halting phase of the most demanding scenario for airlift within the MRS BURU: a major conflict in Korea followed by another in Southwest Asia. The Air Force expects to release the results of the study to the Congress after November 1995, when the Pentagon's Defense Acquisition Board will set DoD's course for future purchases of strategic airlift planes.

In the SAFMA study, the Air Force uses a model that simulates the deliveries of individual planes to estimate the number of C-33s that would be necessary to complement various purchases of C-17s: for instance, if the Air Force stopped C-17 procurement at 40, 58, 72, 86, or 100 planes. For each of those quantities, the model calculates how many C-33s are needed to precisely match the delivery of outsize, oversize, and bulk cargo provided by a fleet with 120 C-17s. Using that approach,

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6. General Accounting Office, *C-17 Aircraft*, p. 36.

7. Greer, *Cost and Operational Effectiveness Analysis of the C-17 Program.*

a fleet with fewer planes that can carry outsize cargo (that is, with more C-33s) might come quite close to delivering as much cargo as 80 additional C-17s, yet never exactly match their output—and therefore might not be considered a viable alternative. Nonetheless, prepositioning such outsize equipment near a region of potential conflict while purchasing a mixture of strategic airlifters might be more cost-effective.

## Missions Unique to the Military

A fleet with a larger number of C-17s may be better able to conduct specialized missions. The Army, for example, has a military requirement to be able to perform airdrop operations with brigade-size forces, possibly over intercontinental distances. And some military officials envision using the C-17 to transfer outsize cargo within a war theater or to deliver cargo directly from the United States near the frontline of a conflict.

Aside from requirements to airlift cargo to major regional conflicts, the appropriate mix of planes in the Air Force's fleet depends on how often DoD needs to perform those specialized missions, and how much defense leaders and the Congress are willing to pay for that capability. The Secretary of Defense's Director for Program Analysis and Evaluation has been conducting a Tactical Utility Analysis to provide information about how much flexibility more C-17s would provide compared with various mixtures of planes. That study analyzes how well various fleets would perform strategic brigade airdrops, deliver cargo to lesser regional contingencies, provide strategic deliveries directly to forward airfields, or reposition equipment within a theater. Although its results have not yet been released to the Congress, press reports suggest that conducting brigade-size airdrops could require larger numbers of C-17s—as could using C-17s for intratheater deliveries, since those planes used as tactical airlifters might not be available for a strategic deployment.[8]

Strategic Brigade Airdrop. One mission that separates the C-17 from its competitors is strategic brigade airdrop—planned as a forced-entry operation in which airborne troops and equipment are dropped after traveling long distances. Such a mission would be followed by equipment delivered by aircraft that land at nearby airfields.

Current plans are to use the C-17 for the airdrop mission as C-141 Starlifters are retired from service. Initially, paratroopers had difficulty jumping from the C-17.

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8. David A. Fulghum, "Defense Studies Back Large C-17, C-33 Buys," *Aviation Week & Space Technology*, September 18, 1995, p. 26; and "Joint Chiefs to Push C-17, C-33 Mix," *Aviation Week & Space Technology*, October 2, 1995, pp. 63-64.

For example, some paratroopers came into contact with their deployment bags during mass jumps, and Army and Air Force officials feared that parachute lines would become entangled when jumpers exited from opposite sides of the aircraft. In order to fix those problems, the Air Force and the Army have changed operational procedures to avoid parachute entanglements. For example, the Army has lengthened the static line to which deployment bags are attached, raised the C-17's angle of attack during paratrooper deployment, and limited the aircraft's weight during jumps. Although those changes ensure that paratroopers can jump safely, if the C-17's weight is reduced by carrying less fuel, its range when conducting airdrop operations may be limited.

In case DoD should purchase fewer than 120 C-17s, the Air Force has also conducted three sets of airdrop tests on its C-5s. During those evaluations, the parachutes of test dummies were hit by the plane's wake. The Army would like to see further evaluation of the C-5 before plans are made to use it for air-dropping either heavy equipment or personnel. Although the Air Force is not pursuing plans to drop paratroopers from the C-5, officials do believe it can be used to air-drop heavy equipment and containerized delivery system bundles.

The Army has air-dropped paratroopers in actual missions only rarely —airborne forces were dropped in 1983 during Operation Urgent Fury in Grenada and in 1989 during Operation Just Cause in Panama. Reportedly, an airdrop operation was planned for September 1994 if the introduction of troops into Haiti was to be a forced-entry operation. However, those examples are all cases in which the C-130, a tactical airlift plane that is used routinely for shorter-range airdrop missions, could be employed. A brigade airdrop over strategic distances would be more demanding, which has led some analysts to suggest that it is an unlikely event. Reports suggest that defense planners were considering a brigade airdrop during Desert Shield/Desert Storm but ultimately decided otherwise.

Lesser Regional Contingencies. Smaller operations can include a wide variety of contingencies from humanitarian relief efforts to conflicts short of large-scale warfare. Operations in Somalia, Rwanda, Haiti, and Bosnia are some recent examples. Smaller-scale operations would most likely be conducted without the benefit of activating reserve aircrews or the Civil Reserve Air Fleet, and thus they could heavily tax the active component of strategic airlift forces.

It may be difficult to gain access to some future battlefields because of rough terrain or lack of roads, railroads, or major airfields. In those cases, the C-17 may hold an advantage over the C-5D and C-33 because of its ability to take off and land on 3,000-foot runways. By comparison, the C-5 typically requires a runway of nearly 5,000 feet, and the C-33 would require a major airfield about 10,000 feet long. Cargo deliveries to contingencies in Korea and Southwest Asia would probably not

be constrained severely because of airfields with short runways. If, however, lesser regional contingencies took place in countries with limited airfields, the C-17's short-field takeoff and landing capability could be important. (C-130s can also land on 3,000-foot runways, but they cannot carry outsize cargo.)

Critics have pointed out that since the C-17 distributes its weight load over fewer wheels than other military transports, such as the C-5, a C-17 landing can put significant stress on a runway's pavement.[9] That stress might be more severe if fuel was unavailable at an airfield, since the C-17 would be heavier because it would need to carry more fuel for its return flight. Nevertheless, in considering both runway length and weight-bearing capacity, the C-17 can land on approximately 3,700 airfields outside the United States compared with 2,300 for the C-5.

Direct Delivery. Under the concept of direct delivery, strategic airlifters would carry cargo intercontinental distances to airfields near the battle front, bypassing main operating bases. Today, C-130s are used to relocate critical supplies to forward airfields; most vehicles, however, can either be driven or flown to a battle front, and other equipment is moved by ground transportation.

Like other military transports such as the C-5, the C-17 has redundant systems and other specialized equipment to help it detect, avoid, and survive missiles and antiaircraft artillery. Military planes can also load and unload equipment quickly so that they can minimize their time in a hostile environment.

As part of the Tactical Utility Analysis, DoD's Director for Program Analysis and Evaluation is analyzing the importance of direct delivery within the context of a major regional contingency. Using strategic airlifters in that manner could reduce the amount of time needed to deliver specific units to a battle front. The analysis should provide some insight into whether those missions could significantly lessen the amount of time needed to deliver forces to a conflict.

Yet some analysts question whether or how frequently the C-17 would be used for direct delivery. Historically, the Army has preferred to deploy into main operating bases rather than forward airfields, allowing troops time to mass forces before initiating maneuvers.[10] Nor is direct delivery a major factor in DoD's planning for two major regional contingencies, although it may be more important for smaller operations. And some people question whether such a costly aircraft would be used in a hostile environment.

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9. Gebman, Batchelder, and Poehlmann, *Finding the Right Mix of Military and Civil Aircraft*, Chapter 5.

10. General Accounting Office, *C-17 Aircraft*, p. 14.

Intratheater Deliveries. Currently, the C-130 is the primary aircraft that the Air Force uses for tactical airlift operations. Although it performs that mission very capably, its cargo hold cannot fit outsize equipment. If the C-17 was used for intratheater missions, it would provide the capability to quickly reposition key pieces of equipment such as Patriot missiles or multiple rocket launch systems. The Tactical Utility Analysis will address what role the C-17 might play in moving units within Korea or Southwest Asia.

However, there may be reason to question whether the C-17 would be used for intratheater deliveries, particularly during major regional contingencies. When the Air Force first planned to purchase 210 planes during the Cold War, it intended for the C-17 to routinely move cargo within a theater, replacing C-130s that it planned to retire. A 1990 Major Aircraft Review of the C-17 reduced the size of that purchase to 120 planes. With a smaller fleet, using some C-17s as intratheater airlifters could increase the amount of time needed to deliver forces from the United States. Moreover, the Air Force does not now envision retiring many of its C-130s, so they can continue to fill the intratheater role.

## Costs of Various Airlift Options

Details about contractors' specific proposals to build strategic airlift planes have been closely held. Press reports suggest, however, that competitive pressures among the three alternative aircraft have led to prices that are lower than expected. Costs are often stated in terms of flyaway cost—typically, the average unit price including the airframe and government-furnished equipment but excluding other items such as initial spare parts, support equipment, and government project management.

Future Costs of the C-17. In April 1995, the Air Force notified the Congress that it expects to pay an average flyaway price of $212 million each (in 1995 dollars) for an additional 80 C-17s. According to press accounts, McDonnell Douglas has since proposed selling its portion of those 80 planes (which excludes engines and some avionics equipment) at an average flyaway price of $190 million apiece.[11] By comparison, the first 40 C-17s had an estimated average recurring flyaway cost of about $300 million each (in 1995 dollars). (Throughout the rest of the memorandum, prices are shown in constant dollars—that is, adjusted for future inflation. However, current-dollar prices are the appropriate values to use for budgeting purposes.)

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11. Jeff Cole, "McDonnell Douglas Offers to Cut Price of C-17 Military Planes by Up to 40%," *Wall Street Journal*, July 31, 1995, p. A3; Tony Capaccio, "Boeing Proposal for C-17 Complement 'Viable,' Say AF Officials," *Defense Week*, September 25, 1995, p. 3.

The question at hand is how much the plane's producer can lower its costs. If DoD and the Congress agreed to purchase more than 40 C-17s, unit production costs would be expected to decline somewhat through learning. And average costs would also decline if the plane's annual rate of production was increased above its current level of eight per year. Some costs already appear to be dropping. For example, as a result of a review by the Air Force of what the C-17 should cost, McDonnell Douglas has begun transferring some of its manufacturing to its more efficient plants, reducing the number of assembly labor hours per plane, and lowering direct support costs. If those measures are pursued aggressively, lower costs may be possible.

CBO analyzed the feasibility of lowering costs for another 80 C-17s. Based on the cost histories of other large aircraft, CBO believes that an average flyaway cost of $203 million (in 1995 dollars) for 80 additional C-17s is consistent with learning efficiencies achieved in similar programs. Including the associated costs of support and initial spare parts would result in an average unit procurement cost of $251 million (in 1995 dollars).

The Air Force plans to award three contracts for every future C-17 production lot: one large contract for manufacturing the aircraft and two smaller ones covering field support (integrated logistics support, initial spare parts, and the like) and additional cost reduction initiatives or possible aircraft upgrades (called producibility enhancement/product improvement, or PE/PI). That three-contract approach was designed to increase the visibility of distinct elements of the program.

The C-17 program may face cost risks relating to the structure of production contracts for future lots. The Air Force is now negotiating with McDonnell Douglas on a firm, fixed-price contract with economic price adjustments for manufacturing airframes in the lot covering planes 33 to 40, along with fixed-price options for three subsequent lots and not-to-exceed contract options for any remaining production lots. Whether the Air Force can exercise those options will depend on annual appropriations by the Congress. Once the C-17 moved to a higher annual production rate, DoD would have to pay a price penalty if the Congress chose to purchase fewer aircraft in any future year, and prices for all subsequent lots would be open to renegotiation. That risk may be important at a time when the Congress is adding acquisition programs to the defense budget and, simultaneously, trying to eliminate the federal budget deficit.

Having three contracts governing each production lot could also pose some risk. The largest contract, which covers manufacturing, will be structured as a fixed-price contract in which the contractor bears the brunt if those costs are higher than expected. However, the structure and content of the field support and PE/PI contracts have not yet been established. DoD will need to be vigilant in monitoring

the C-17 program to make sure that manufacturing costs are not redistributed to the two smaller contracts.

Costs of Alternative Aircraft. The C-17's alternatives are subject to varying degrees of cost risk. Boeing has built more than 1,000 747 airframes in different configurations, which suggests that the cost risk associated with procuring C-33s is low. The Air Force would need to budget between $275 million and $300 million in development costs, however, in order to fit the 747-400 freighter with a wider side door and stronger floors. Two firm, fixed-price contracts with economic price adjustments would govern the manufacturing of C-33s—one covering the aircraft system and another for contractor logistics support.

Lockheed Martin's proposal for the C-5D model incorporates substantial changes from the existing C-5B that could improve the reliability of a plane that had significant maintenance problems during the Persian Gulf War.[12] Major upgrades include a new engine (the General Electric CF6-80C2, which is used on some 747s, 767s, Airbus 300s, and MD-11s), a new digital cockpit with the same avionics software that is being developed for the C-130J, and a number of other measures to improve the reliability and maintainability of the plane.

Lockheed demonstrated its ability to restart C-5 production when it produced the C-5B during the 1980s. Based on that experience, CBO estimates that the manufacturer could reopen the production line using much of the same production equipment at a start-up cost of $850 million. Those costs could be higher, however, if new tooling and production equipment is required. Since the D model includes significant upgrades that have not yet been demonstrated, there may be a greater degree of technical risk associated with that program than with the C-17 or C-33. For example, it is unclear whether the development schedule for the cockpit is achievable or whether it could result in program delays. A restart of the C-5 production line would most likely be governed by a fixed-price contract that covers start-up costs and airframe manufacturing and possibly another that covers contractor logistics support.

Acquisition Costs for Three Illustrative Options. The flyaway price can be a misleading measure for comparing the C-17 with alternative aircraft because it does not reflect all costs that the government would need to incur. Moreover, because the C-33 and C-5D can carry larger average payloads than the C-17, the Air Force might need fewer than 80 of them.

A better approach is to compare the full cost that the Air Force would need to pay in order to complete its strategic airlift acquisition program. That full cost

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12. John Lund, Ruth Berg, and Corinne Replogle, *An Assessment of Strategic Airlift Operational Efficiency*, R-4269/4-AF (Santa Monica, Calif.: RAND, 1993).

includes not only total flyaway costs but any additional development costs as well as initial spare parts, training, and other support equipment. Since the costs of operating and supporting an aircraft over its service life are sometimes larger than acquisition costs, they are extremely important as well.

To provide an idea of the range of alternatives, CBO estimated the costs of acquiring 80 additional C-17s, buying only C-5Ds, or purchasing a mixture of C-17s and C-33s. DoD is considering a much larger number of airlift alternatives than those provided here—these should be considered illustrative, not exhaustive.

CBO designed the options such that, when combined with the Air Force's expected strategic airlift fleet for 2006 (including no C-141s but 104 C-5A/Bs, 37 KC-10s devoted to airlift, and CRAF Stage 2), each option would be able to deliver the same amount of cargo to a single Southwest Asian contingency within the same two- to three-week period. CBO did not estimate cargo deliveries for a conflict on the Korean Peninsula or for two nearly simultaneous contingencies.

To make those estimates, CBO used the Airlift Cycle Assessment System (ACAS), a spreadsheet model developed by the Air Force for simple estimates of delivery capability. The ACAS model does not simulate the loading, departure, and landing of individual planes. Instead, it calculates how quickly a fleet can deliver a specific amount of bulk, outsize, and oversize cargo tonnage by distributing that weight among the airlift fleet based on the average payload of each type of aircraft. Since real-world airlift deliveries are also constrained by the shape and volume of individual pieces of equipment, the ACAS model probably understates the amount of time required to deliver cargo. Requirements were provided by the Department of Defense and match the shares of outsize, oversize, and bulk cargo planned for a deployment to Southwest Asia.

CBO's calculations assume that Southwest Asian and en route airfields have adequate ramp space, refueling supplies, material-handling equipment, and personnel to unload and service planes—in other words, that maximum on-the-ground (MOG) constraints are not very restrictive. If those resources were constrained, each option would take considerably longer than two to three weeks to deliver the cargo. Since the C-17 is smaller and more maneuverable on the ground than the C-33 or C-5D, those options with more C-17s might take less time to complete deliveries when airfield space was limited.

In its 1993 analysis, the Institute for Defense Analyses looked at how sensitive airlift deliveries are to airfield constraints by restricting the amount of space available at airfields to that experienced during the first 45 days of Operation Desert

Shield.[13] Under those conditions, it concluded, options with larger numbers of C-17s performed better. If space is equally constrained in the future, airfields may not be able to accommodate numerous large planes at the same time.

But would those same conditions exist in the future? Very few airfields were available to unload equipment during the early part of the Gulf War: nearly 60 percent of airlift missions were unloaded in Dhahran, and some airfields such as those in King Khalid Military City and at King Fahd International Airport were used only minimally or did not open until later in the operation.[14] Based on that experience, caution might argue in favor of assuming that conditions would be the same in the future. However, the United States has kept a military presence in the Persian Gulf since that war—an indication that countries such as Saudi Arabia may be more willing to open their facilities to U.S. forces.

All estimates of cargo deliveries are extremely sensitive to assumptions about MOG constraints. Frequently, airlift models assume that a single value adequately captures all aspects of MOG: often, it is characterized as the maximum number of aircraft that can be serviced simultaneously at an airfield. However, airlift deliveries depend not only on the amount of ramp space but also on the availability of fuel, equipment to unload cargo, ground transportation vehicles, and personnel to service the aircraft. For example, early airlift deliveries to Saudi Arabia were constrained not only by lack of access to airfields but also by too few trucks and drivers to move fuel from storage facilities to aircraft that needed refueling.[15] Once military officials realized the problem, they sent additional trucks and personnel to ease the situation. Some military officials believe that during the Gulf War, the availability of fuel constrained airlift operations more tightly than airfield ramp space.[16] If that is true, deliveries by smaller planes might not fare any better than those by larger ones.

By assuming that adequate ramp space is available, CBO's calculations may overstate the delivery capability of alternatives that include large planes such as the C-5D or C-33. However, other factors might constrain airlift operations more than ramp space, and thus it may not be appropriate to rule out options that include large planes. Moreover, improving the factors that limit airlift deliveries might be less expensive than purchasing enough planes to overcome those constraints.

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13. Greer, *Cost and Operational Effectiveness Analysis of the C-17 Program*, p. 62.

14. Lund, Berg, and Replogle, *An Assessment of Strategic Airlift Operational Efficiency*, pp. 41-45.

15. U.S. Air Force, *Gulf War Air Power Survey*, vol. 3, *Logistics and Support* (1993), p. 101.

16. Gebman, Batchelder, and Poehlmann, *Finding the Right Mix of Military and Civil Aircraft*, vol. 3, *Appendixes*, pp. 37-38.

Buying 80 additional C-17s, for a total of 120, would provide the Air Force with the most flexibility for addressing a wide range of military missions. CBO estimates that purchasing 80 more C-17s would cost $13 billion over the 1997-2001 period. (All costs are in 1996 dollars; see Table 1. Table A-1 in the appendix shows CBO's estimate of the costs of options in current dollars.) Total acquisition costs for all 80 planes would run to $20.7 billion. CBO estimates that the cost of manning and operating 80 additional C-17s through 2020 would be $15.5 billion, bringing total costs for buying and operating the planes to $36.2 billion over the next 24 years. This option would appeal to policymakers who believe that the United States is likely to become involved in conflicts in which DoD would need to use short runways or specialized missions such as strategic brigade airdrop, or who believe that airfields will be tightly constrained during future major regional contingencies.

Under Option 2, DoD would halt the C-17 program at 40 planes and reopen the C-5 production line to manufacture the D model. CBO estimates that procuring 65 C-5Ds would cost $9.7 billion over the 1997-2001 period and $11.7 billion over the entire procurement program (in 1996 dollars). Operating and supporting 65 C-5Ds until 2020 would cost $15.5 billion, bringing the total for procuring and operating those planes to $27.2 billion over the next 24 years. Option 2 would cost $9 billion less to purchase than Option 1 but just as much to operate and support.

Assuming that airfields had adequate space, a mixture of 40 C-17s and 65 C-5Ds would provide the same amount of delivery capability within the first two to three weeks of a major regional contingency as 80 additional C-17s. This procurement approach would also give the Air Force an airlift fleet with more planes that can carry outsize equipment compared with fleets that include C-33s.

If space at airfields is constrained, however, a fleet with greater numbers of large planes like the C-5 may not be able to deliver cargo as quickly. Nor can the C-5D handle some types of military operations that the C-17 can, such as delivering cargo in regions that have the shortest runways. With continued operational testing, the C-5 might eventually provide the Army with limited capability for airdrop, but the Air Force has decided that the plane will not be used to air-drop personnel. Nor is it likely that the Air Force would use the C-5 to deliver equipment to forward areas of military operations.

Option 3, procuring 32 additional C-17s plus 30 C-33s, would cost $13.3 billion over the 1997-2001 period and $15.5 billion through completion of the acquisition program (in 1996 dollars). CBO estimates that the cost of operating and supporting the additional C-17s and C-33s would total $12.9 billion through 2020, bringing total costs for the alternative to $28.3 billion over the 24-year period. Relative to Option 1, this alternative would cost more than $5 billion less to purchase and nearly $3 billion less to operate through 2020.

TABLE 1. ESTIMATED COSTS IN 1996 DOLLARS OF THREE STRATEGIC AIRLIFT OPTIONS (In millions)

| | 1997 | 1998 | 1999 | 2000 | 2001 | Total, 1997-2001 | Total, 1997-2020 |
|---|---|---|---|---|---|---|---|
| **Option 1: Buy 80 Additional C-17s** | | | | | | | |
| Quantity Purchased | 8 | 8 | 8 | 10 | 12 | 46 | 80 |
| Acquisition Costs | 2,510 | 2,490 | 2,430 | 2,670 | 2,910 | 13,010 | 20,730 |
| Operation and Support Costs | 0 | 0 | 50 | 140 | 250 | 440 | 15,470 |
| Total Costs | 2,510 | 2,490 | 2,480 | 2,810 | 3,160 | 13,450 | 36,200 |
| **Option 2: Buy 65 C-5Ds** | | | | | | | |
| Quantity Purchased | 4 | 10 | 12 | 12 | 12 | 50 | 65 |
| Acquisition Costs | 2,420[a] | 2,010 | 1,840 | 1,780 | 1,630 | 9,680 | 11,690 |
| Operation and Support Costs | 0 | 0 | 0 | 120 | 290 | 410 | 15,540 |
| Total Costs | 2,420 | 2,010 | 1,840 | 1,900 | 1,920 | 10,090 | 27,230 |
| **Option 3: Buy 32 Additional C-17s and 30 C-33s** | | | | | | | |
| Quantity of C-17s Purchased | 8 | 8 | 8 | 8 | 0 | 32 | 32 |
| Quantity of C-33s Purchased | 1 | 1 | 6 | 6 | 6 | 20 | 30 |
| Acquisition Costs | 2,930[b] | 2,660 | 3,400 | 3,120[c] | 1,170 | 13,280 | 15,470 |
| Operation and Support Costs | 0 | 0 | 50 | 140 | 290 | 480 | 12,850 |
| Total Costs | 2,930 | 2,660 | 3,450 | 3,260 | 1,460 | 13,760 | 28,320 |

SOURCE: Congressional Budget Office.

NOTE: All options exclude any costs associated with procuring or operating the first 40 C-17s.

a. Includes $850 million for the cost of restarting the C-5 production line.

b. Includes $275 million in costs to develop the C-33.

c. Cost declines in 2000 because advanced procurement funds are no longer needed for the C-17.

The third option would also provide the same amount of delivery capability as 80 additional C-17s when airfields were not constrained. Given the current emphasis on prepositioning outsize materials for major regional contingencies, outsize cargo makes up a smaller share of airlift requirements than before. Under those conditions, a fleet with fewer planes that are capable of carrying outsize cargo may still provide sufficient delivery capability.

Such a fleet could not, however, handle unique military missions as well as 80 more C-17s. And if little ramp space was available in future major regional conflicts, a fleet with C-33s probably would not be able to deliver cargo as quickly as 80 more C-17s. (The C-17 is better able to maneuver on the ground, and the large size of the C-33 and the long runway it requires could limit airlift deliveries.)

However, a mix of 32 more C-17s and 30 C-33s might still provide sufficient capability. For example, if the Air Force decided to use its existing C-5s to air-drop heavy equipment, it could conduct some airdrop missions using a combination of C-5s and C-17s. Policymakers might choose this option if they believe the United States will probably not need to conduct military missions such as air-dropping an entire brigade of troops or delivering cargo directly to forward airfields.

Following Air Force planning, CBO's estimates assume that the C-17 will operate many more hours per year than either the C-5D or the C-33. The Air Force plans to fly the C-33 just 650 hours per year, compared with 1,430 hours per year for the C-17 (see Table 2). Thus, the C-33's costs for operation and support (O&S) are considerably lower—$10 million per plane rather than $13 million for the C-17 (in 1996 dollars). The C-5D would fly 440 fewer hours each year than the C-17, but its O&S costs per plane would be higher.

CBO estimates that, on a per-hour basis, O&S costs for the C-17 are lower than for either alternative, averaging $9,100 per flight hour compared with $15,900 per flight hour for the C-33 and $14,900 for the C-5D. The Air Force could lower the C-17's total O&S costs by changing the mix of active-duty and reserve pilots who fly the plane or simply reducing its annual flying time.

TABLE 2. ESTIMATED ANNUAL OPERATION AND SUPPORT COSTS FOR SELECTED AIRLIFT AIRCRAFT

| Type of Aircraft | Number and Type of Crew per Aircraft | Number of Aircraft per Squadron | Flying Hours per Aircraft | Cost per Aircraft (Millions of 1996 dollars) | Cost per Flying Hour (Thousands of 1996 dollars) |
|---|---|---|---|---|---|
| C-17 | 3.0 Active and 2.0 Reserve Crews | 12 | 1,430 | 13.0 | 9.1 |
| C-5D | 1.8 Active and 1.8 Reserve Crews | 16 | 990 | 14.7 | 14.9 |
| C-33 | 1.5 Active and 3.5 Reserve Crews | 13 | 650 | 10.3 | 15.9 |

SOURCE: Congressional Budget Office compilation of estimates from the Air Force's Systematic Approach to Better Long-Range Estimating (SABLE) model, version 95-1, December 1994, and estimates by contractors.

NOTE: Operation and support (O&S) cost estimates are based on many factors, such as the number of crews per aircraft, the type of crew per aircraft (active, reserve, or both), the number of aircraft per squadron, and the number of flying hours per aircraft. Based on the available data, CBO is unable to calculate an O&S cost per aircraft that considers all of those factors uniformly for all aircraft. These estimates do not necessarily equal budgeted amounts because they are based on mathematical models that approximate long-run costs.

## APPENDIX: SUPPLEMENTAL TABLE

TABLE A-1. ESTIMATED COSTS IN CURRENT DOLLARS OF THREE STRATEGIC AIRLIFT OPTIONS (In millions)

| | 1997 | 1998 | 1999 | 2000 | 2001 | Total, 1997-2001 | Total, 1997-2020 |
|---|---|---|---|---|---|---|---|
| **Option 1: Buy 80 Additional C-17s** | | | | | | | |
| Quantity Purchased | 8 | 8 | 8 | 10 | 12 | 46 | 80 |
| Acquisition Costs | 2,760 | 2,820 | 2,840 | 3,210 | 3,600 | 15,230 | 25,350 |
| Operation and Support Costs | 0 | 0 | 50 | 160 | 290 | 500 | 25,410 |
| Total Costs | 2,760 | 2,820 | 2,890 | 3,370 | 3,890 | 15,730 | 50,760 |
| **Option 2: Buy 65 C-5Ds** | | | | | | | |
| Quantity Purchased | 4 | 10 | 12 | 12 | 12 | 50 | 65 |
| Acquisition Costs | 2,660[a] | 2,280 | 2,140 | 2,140 | 2,020 | 11,240 | 13,840 |
| Operation and Support Costs | 0 | 0 | 0 | 140 | 350 | 490 | 25,270 |
| Total Costs | 2,660 | 2,280 | 2,140 | 2,280 | 2,370 | 11,730 | 39,110 |
| **Option 3: Buy 32 Additional C-17s and 30 C-33s** | | | | | | | |
| Quantity of C-17s Purchased | 8 | 8 | 8 | 8 | 0 | 32 | 32 |
| Quantity of C-33s Purchased | 1 | 1 | 6 | 6 | 6 | 20 | 30 |
| Acquisition Costs | 3,220[b] | 3,020 | 3,970 | 3,750[c] | 1,450 | 15,410 | 18,260 |
| Operation and Support Costs | 0 | 0 | 50 | 160 | 350 | 560 | 20,800 |
| Total Costs | 3,220 | 3,020 | 4,020 | 3,910 | 1,800 | 15,970 | 39,060 |

SOURCE: Congressional Budget Office.

NOTE: All options exclude any costs associated with procuring or operating the first 40 C-17s.

a. Includes $850 million for the cost of restarting the C-5 production line.

b. Includes $275 million in costs to develop the C-33.

c. Cost declines in 2000 because advanced procurement funds are no longer needed for the C-17.